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INAUGURAL ADDRESS BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.[1]

UNDER the title 'Darwinism' it is convenient to designate the various work of biologists tending to establish, develop or modify Mr. Darwin's great theory of the origin of species. In looking back over twenty-five years it seems to me that we must say that the conclusions of Darwin as to the origin of species by the survival of selected races in the struggle for existence are more firmly established than ever. And this because there have been many attempts to gravely tamper with essential parts of the fabric as he left it, and even to substitute conceptions for those which he endeavored to establish, at variance with his conclusions. These attempts must, I think, be considered as having failed. A great deal of valuable work has been done in consequence; for honest criticism, based on observation and experiment, leads to further investigation, and is the legitimate and natural mode of increase of scientific knowledge. Amongst the attempts to seriously modify Darwin's doctrine may be cited that to assign a great and leading importance to Lamarck's theory as to the transmission by inheritance of newly 'acquired' characters, due chiefly to American paleontologists and to the venerated defender of such views, who has now closed his long life of great work, Mr. Herbert Spencer; that to attribute leading importance to the action of physiological con-

[1] Concluding part of the address given by Dr. E. Ray Lankester, at York, on August 1, 1906.

gruity and incongruity in selective breeding, which was put forward by another able writer and naturalist who has now passed from among us, Dr. George Romanes; further, the views of de Vries as to discontinuity in the origin of new species, supported by the valuable work of Mr. Bateson on discontinuous variation; and lastly, the attempt to assign a great and general importance to the facts ascertained many years ago by the Abbé Mendel as to the cross-breeding of varieties and the frequent production (in regard to certain characters in certain cases) of pure strains rather than of breeds combining the characters of both parents. On the other hand, we have the splendid series of observations and writings of August Weismann, who has in the opinion of the majority of those who study this subject rendered the Lamarckian theory of the origin and transmission of new characters altogether untenable, and has, besides, furnished a most instructive, if not finally conclusive, theory or mechanical scheme of the phenomena of heredity in his book, 'The Germ-plasm.' Professor Karl Pearson and the late Professor Weldon—the latter so early in life and so recently lost to us—have, with the finest courage and enthusiasm in the face of an enormous and difficult task, determined to bring the facts of variation and heredity into the solid form of statistical statement, and have organized, and largely advanced in, this branch of investigation, which they have termed 'Biometrics.' Many naturalists throughout the world have made it the main object of their collecting and breeding of insects, birds and plants, to test Darwin's generalizations and to expand the work of Wallace in the same direction. A delightful fact in this survey is that we find Mr. Alfred Russel Wallace (who fifty years ago conceived the same theory as that more fully stated by Darwin) actively working and publishing some of the most convincing and valuable works on Darwinism. He is still alive and not merely well, but pursuing his work with vigor and ability. It was chiefly through his researches on insects in South America and the Malay Islands that Mr. Wallace was led to the Darwinian theory; and there is no doubt that the study of insects, especially of butterflies, is still one of the most prolific fields in which new facts can be gathered in support of Darwin and new views on the subject tested. Prominent amongst naturalists in this line of research has been and is Edward Poulton, of Oxford, who has handed on to the study of entomology throughout the world the impetus of the Darwinian theory. I must here also name a writer who, though unknown in our laboratories and museums, seems to me to have rendered very valuable service in later years to the testing of Darwin's doctrines and to the bringing of a great class of organic phenomena within the cognizance of those naturalists who are especially occupied with the problems of variation and heredity. I mean Dr. Archdall Reid, who has with keen logic made use of the immense accumulation of material which is in the hands of medical men, and has pointed out the urgent importance of increased use by Darwinian investigators of the facts as to the variation and heredity of that unique animal, man, unique in his abundance, his reproductive activity, and his power of assisting his investigator by his own record. There are more observations about the variation and heredity of man and the conditions attendant upon individual instances than with regard to any other animal. Medical men need only to grasp clearly the questions at present under discussion in order to be able to furnish with ease data absolutely invaluable in quantity and quality. Dr. Archdall Reid has in two original books full of insight and new suggestions, the 'Present

Evolution of Man' and 'Principles of Heredity,' shown a new path for investigators to follow.

The attempt to resuscitate Lamarck's views on the inheritance of acquired[2] characters has been met not only by the demand for the production of experimental proof that such inheritance takes place, which has never been produced, but on Weismann's part by a demonstration that the reproductive cells of organisms are developed and set aside from the rest of the tissues at so early a period that it is extremely improbable that changes brought about in those other tissues by unaccustomed incident forces can be communicated to the germ-cells so as to make their appearance in the offspring by heredity. Apart from this, I have drawn attention to the fact that Lamarck's first and second laws (as he terms them) of heredity are contradictory the one of the other, and therefore may be dismissed. In 1894 I wrote:

> Normal conditions of environment have for many thousands of generations moulded the individuals of a given species of organism, and determined as each individual developed and grew 'responsive' quantities in its parts (characters); yet, as Lamarck tells us, and as we know, there is in every individual born a potentiality which has *not* been extinguished. Change the normal conditions of the species in the case of a young individual taken to-day from the site where for thousands of generations its ancestors have responded in a perfectly defined way to the normal and defined conditions of environment; reduce the daily or the seasonal amount of solar radiation to which the individual is exposed; or remove the aqueous vapor from the atmosphere; or alter the chemical composition of the pabulum accessible; or force the individual to previously unaccustomed muscular effort or to new pressures and strains; and (as Lamarck bids us observe), in spite of all the long-continued response to the earlier normal specific conditions, the innate congenital potentiality shows itself. The individual under the new quantities of environing agencies shows *new* responsive quantities in those parts of its structure concerned, new or *acquired* characters.
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> So far, so good. What Lamarck next asks us to accept, as his 'second law,' seems not only to lack the support of experimental proof, but to be inconsistent with what has just preceded it. The new character which is *ex hypothesi*, as was the old character (length, breadth, weight of a part) which it has replaced—a response to environment, a particular moulding or manipulation by incident forces of the potential congenital quality of the race—is, according to Lamarck, all of a sudden raised to extraordinary powers. The new or freshly acquired character is declared by Lamarck and his adherents to be capable of transmission by generation; that is to say, it alters the potential character of the species. It is no longer a merely responsive or reactive character, determined quantitatively by quantitative conditions of the environment, but becomes fixed and incorporated in the potential of the race, so as to persist when other quantitative external conditions are substituted for those which originally determined it. In opposition to Lamarck, one must urge, in the first place, that this thing has never been shown experimentally to occur; and in the second place, that there is no ground for holding its occurrence to be probable, but, on the contrary, strong reason for holding it to be improbable. Since the old character (length, breadth, weight) had not become fixed and congenital after many thousands of successive generations of individuals had developed it in response to environment, but gave place to a new character when new conditions operated on an individual (Lamarck's first law), why should we suppose that the new character is likely to become fixed after a much shorter time of responsive existence, or to escape the operation of the first law? Clearly there is no reason (so far as Lamarck's statement goes) for any such supposition, and the two so-called laws of Lamarck are at variance with one another.

In its most condensed form my argument has been stated thus by Professor Poulton: Lamarck's "first law assumes that a past history of indefinite duration is powerless to create a bias by which the present can be controlled; while the second assumes that the brief history of the present can readily raise a bias to control the future" (*Nature*, Vol. LI., 1894, p. 127).

[2] I use the term 'acquired' without prejudice in the sense given to that word by Lamarck himself.

An important light is thrown on some facts which seem at first sight to favor the Lamarckian hypothesis by the consideration that, though an 'acquired' character is not transmitted to offspring as the consequence of the action of external agencies determining the 'acquirement,' yet the tendency to react exhibited by the parent *is* transmitted, and if the tendency is exceptionally great a false suggestion of a Lamarckian inheritance can readily result. This inheritance of 'variation in tendencies to react' has a wide application, and has led me to coin the word 'educability' as mentioned in the section of this address on psychology.

The principle of physiological selection advocated by Dr. Romanes does not seem to have caused much discussion, and has been unduly neglected by subsequent writers. It was ingenious, and was based on some interesting observations, but has failed to gain support.

The observations of de Vries—showing that in cultivated varieties of plants a new form will sometimes assert itself suddenly and attain a certain period of dominance, though not having been gradually brought into existence by a slow process of selection—have been considered by him, and by a good many naturalists, as indicating the way in which new species arise in nature. The suggestion is a valuable one if not very novel, but a great deal of observation will have to be made before it can be admitted as really having a wide bearing upon the origin of species. The same is true of those interesting observations which were first made by Mendel, and have been resuscitated and extended with great labor and ingenuity by recent workers, especially in this country by Bateson and his pupils. If it should prove to be true that varieties when crossed do not, in the course of eventual interbreeding, produce intermediate forms as hybrids, but that characters are either dominant or recessive, and that breeds result having pure unmixed characters—we should, in proportion as the Mendelian law is shown to apply to all tissues and organs and to a majority of organisms, have before us a very important and determining principle in all that relates to heredity and variation. It remains, however, to be shown how far the Mendelian phenomenon is general. And it is, of course, admitted on all sides that, even were the Mendelian phenomenon general and raised to the rank of a law of heredity, it would not be subversive of Mr. Darwin's generalizations, but probably tend to the more ready application of them to the explanation of many difficult cases of the structure and distribution of organisms.

Two general principles which Mr. Darwin fully recognized appear to me to deserve more consideration and more general application to the history of species than he had time to give to them, or than his followers have accorded to them. The first is the great principle of 'correlation of variation,' from which it follows that, while natural selection may be favoring some small and obscure change in an unseen group of cells—such as digestive, pigmentary or nervous cells, and that change a change of selective value—there may be, indeed often is, as we know, a correlated or accompanying change in a physiologically related part of far greater magnitude and prominence to the eye of the human onlooker. This accompanying or correlated character has no selective value, is not an adaptation—is, in fact, a necessary but useless by-product. A list of a few cases of this kind was given by Darwin, but it is most desirable that more should be established. For they enable us to understand how it is that specific characters, those seen and noted on the surface by systematists, are not in most cases adaptations of selective value. They also open a wide vista of

incipient and useless developments which may suddenly, in their turn, be seized upon by ever-watchful natural selection and raised to a high pitch of growth and function.

The second, somewhat but by no means altogether neglected, principle is that a good deal of the important variation in both plants and animals is not the variation of a minute part or confined to one organ, but has really an inner physiological basis, and may be a variation of a whole organic system or of a whole tissue expressing itself at several points and in several shapes. In fact, we should perhaps more generally conceive of variation as not so much the accomplishment and presentation of one little mark or difference in weight, length or color, as the expression of a *tendency to vary* in a given tissue or organ in a particular way. Thus we are prepared for the rapid extension and dominance of the variation if once it is favored by selective breeding. It seems to me that such cases as the complete disappearance of scales from the integument of some osseous fishes, or the possible retention of three or four scales out of some hundreds present in nearly allied forms, favor this mode of conceiving of variation. So also does the marked tendency to produce membranous expansions of the integument in the bats, not only between the digits and from the axilla, but from the ears and different regions of the face. Of course, the alternative hairy or smooth condition of the integuments both in plants and animals is a familiar instance in which a tendency extending over a large area is recognized as that which constitutes the variation. In smooth or hairy varieties we do not postulate an individual development of hairs subjected one by one to selection and survival or repression.

The study of the physiology of unhealthy, injured or diseased organisms is called pathology. It necessarily has an immense area of observation and is of transcending interest to mankind, who do not accept their diseases unresistingly and die as animals do, so purifying their race, but incessantly combat and fight disease, producing new and terrible forms of it by their wilful interference with the earlier rule of nature.

Our knowledge of disease has been enormously advanced in the last quarter of a century, and in an important degree our power of arresting it, by two great lines of study going on side by side and originated, not by medical men nor physiologists in the narrow technical sense, but by naturalists, a botanist and a zoologist. Ferdinand Cohn, professor of botany in Breslau, by his own researches and by personal training in his laboratory, gave to Robert Koch the start on his distinguished career as a bacteriologist. It is to Metchnikoff, the zoologist and embryologist, that we owe the doctrine of phagocytosis and the consequent theory of immunity now so widely accepted.

We must not forget that in this same period much of the immortal work of Pasteur on hydrophobia, of Behring and Roux on diphtheria, and of Ehrlich and many others, to whom the eternal gratitude of mankind is due, has been going on. It is only some fifteen years since Calmette showed that if cobra poison were introduced into the blood of a horse in less quantity than would cause death, the horse would tolerate with little disturbance after ten days a full dose, and then day after day an increasing dose, until the horse without any inconvenience received an injection of cobra poison large enough to kill thirty horses of its size. Some of the horse's blood being now withdrawn was found to contain a very active antidote to

cobra poison—what is called an antitoxin. The procedure and preparation of the antitoxin is practically the same as that previously adopted by Behring in the preparation of the antitoxin of diphtheria poison. Animals treated with injections of these antitoxins are immune to the poison itself when subsequently injected with it, or, if already suffering from the poison (as, for instance, by snake-bite), are readily shown by experiment to be rapidly cured by the injection of the appropriate antitoxin. This is, as all will admit, an intensely interesting bit of biology. The explanation of the formation of the antitoxin in the blood and its mode of antagonizing the poison is not easy. It seems that the antitoxin is undoubtedly formed from the corresponding toxin or poison, and that the antagonism can be best understood as a chemical reaction by which the complex molecule of the poison is upset, or effectively modified.

The remarkable development of Metchnikoff's doctrine of phagocytosis during the past quarter of a century is certainly one of the characteristic features of the activity of biological science in that period. At first ridiculed as 'Metchnikoffism,' it has now won the support of its former adversaries.

For a long time the ideal of hygienists has been to preserve man from all contact with the germs of infection, to destroy them and destroy the animals conveying them, such as rats, mosquitoes and other flies. But it has now been borne in upon us that, useful as such attempts are, and great as is the improvement in human conditions which can thus be effected, yet we can not hope for any really complete or satisfactory realization of the ideal of escape from contact with infective germs. The task is beyond human powers. The conviction has now been arrived at that, while we must take every precaution to diminish infection, yet our ultimate safety must come from within—namely, from the activity, the trained, stimulated and carefully guarded activity, of those wonderful colorless amœba-like corpuscles whose use was so long unrecognized, but has now been made clear by the patiently continued experiments and arguments of Metchnikoff, who has named them 'phagocytes.' The doctrine of the activity and immense importance of these corpuscles of the living body which form part of the all-pervading connective tissues and float also in the blood, is in its nature and inception opposed to what are called the 'humoral' and 'vitalistic' theories of resistance to infection. Of this kind were the beliefs that the *liquids* of the living body have an inherent and somewhat vague power of resisting infective germs, and even that the mere living quality of the tissues was in some unknown way antagonistic to foreign intrusive disease-germs.

The first eighteen years of Metchnikoff's career, after his undergraduate course, were devoted to zoological and embryological investigations. He discovered many important facts, such as the alternation of generations in the parasitic worm of the frog's lung—*Ascaris nigrovenosa*—and the history of the growth from the egg of sponges and medusæ. In these latter researches he came into contact with the wonderfully active cells, or living corpuscles, which in many low forms of life can be seen by transparency in the living animal. He saw that these corpuscles (as was indeed already known) resemble the well-known amœba, and can take into their soft substance (protoplasm) at all parts of their surface any minute particles and digest them, thus destroying them. In a transparent water-flea Metchnikoff saw these amœba-like, colorless, floating blood-cor-

puscles swallowing and digesting the spores of a parasitic fungus which had attacked the water-fleas and was causing their death. He came to the conclusion that this is the chief, if not the whole, value of these corpuscles in higher as well as lower animals, in all of which they are very abundant. It was known that when a wound bringing in foreign matter is inflicted on a vertebrate animal the blood-vessels become gorged in the neighborhood and the colorless corpuscles escape through the walls of the vessels in crowds. Their business in so doing, Metchnikoff showed, is to eat up the foreign matter, and also to eat up and remove the dead, wounded tissue. He, therefore, called these white or colorless corpuscles 'phagocytes,' the eater-cells, and in his beautiful book on 'Inflammation,' published twenty years ago, proved the extreme importance of their activity. At the same time he had shown that they eat up intrusive bacteria and other germs; and his work for the last twenty years has mainly consisted in demonstrating that they are the chief, and probably the only, agents at work in either ridding the human body of an attack of disease-causing germs or in warding off even the commencement of an attack, so that the man or animal in which they are fully efficient is 'immune' —that is to say, can not be effectively attacked by disease-germs.

Disease-germs, bacteria or protozoa produce poisons which sometimes are too much for the phagocytes, poisoning them and so getting the upper hand. But, as Metchnikoff showed, the training of the phagocytes by weak doses of the poison of the disease-germ, or by weakened cultures of the disease-germ itself, brings about a power of resistance in the phagocytes to the germ's poison, and thus makes them capable of attacking the germs and keeping them at bay. Hence the value of inoculations.

The discussion and experiments arising from Metchnikoff's demonstrations have led to the discovery of the production by the phagocytes of certain exudations from their substance which have a most important effect in weakening the resistance of the intrusive bacteria and rendering them easy prey for the phagocyte. These are called 'sensitizers,' and have been largely studied. They may be introduced artificially into the blood and tissues so as to facilitate the work of the phagocytes, and no doubt it is a valuable remedial measure to make use of such sensitizers as a treatment. Sir A. E. Wright considers that such sensitizers are formed in the blood and tissues independently of the phagocytes, and has called them 'opsonins,' under which name he has made most valuable application of the method of injecting them into the body so as to facilitate the work of the phagocytes in devouring the hostile bacteria of various diseases. Each kind of disease-producing microbe has its own sensitizer or opsonin; hence there has been much careful research and experiment required in order to bring the discovery to practical use. Metchnikoff himself holds and quotes experiments to show that the 'opsonins' are actually produced by the phagocytes themselves. That this should be so is in accordance with some striking zoological facts, as I pointed out nearly twenty years ago. For the lowest multicellular animals provided with a digestive sac or gut, such as the polyps, have that sac lined by digestive cells which have the same amœboid character as 'phagocytes,' and actually digest to a large extent by swallowing or taking into their individual protoplasm raw particles of food. Such particles are enclosed in a temporary cavity, or vacuole, into which the cell-protoplasm secretes digestive ferment and other chemical agents. Now there is no doubt

that such digestive vacuoles may burst and so pour out into the polyp's stomach a digestive juice which will act on food particles outside the substance of the cells, and thus by the substitution of this process of outpouring of the secretion for that of ingestion of food particles into the cells we get the usual form of digestion by juices secreted into a digestive cavity. Now this being certainly the case in regard to the history of the original phagocytes lining the polyp's gut, it does not seem at all unlikely, but on the contrary in a higher degree probable, that the phagocytes of the blood and tissues should behave in the same way and pour out sensitizers and opsonins to paralyze and prepare their bacterial food. And the experiments of Metchnikoff's pupils and followers show that this is undoubtedly the case. Whether there is any great variety of and difference between 'sensitizers' and 'opsonins' is a matter which is still the subject of active experiment. Metchnikoff's conclusion, as recently stated in regard to the whole progress of this subject, is that the phagocytes in our bodies should be stimulated in their activity in order successfully to fight the germs of infection. Alcohol, opium, and even quinine, hinder the phagocytic action; they should, therefore, be entirely eschewed or used only with great caution where their other and valuable properties are urgently needed. It appears that the injection of blood-serum into the tissues of animals causes an increase in the number and activity of the phagocytes, and thus an increase in their resistance towards pathogenic germs. Thus Durham (who was a pioneer in his observations on the curious phenomena of the 'agglutination' of blood-corpuscles in relation to disease) was led to suggest the injection of sera during surgical operations, and experiments recently quoted by Metchnikoff seem to show that the suggestion was well founded. After years of opposition bravely met in the pure scientific spirit of renewed experiment and demonstration, Metchnikoff is at last able to say that the foundation-stone of the hygiene of the tissues—the thesis that our phagocytes are our arms of defence against infective germs—has been generally accepted.

Another feature of the progress of our knowledge of disease—as a scientific problem—is the recent recognition that minute animal parasites of that low degree of unicellular structure to which the name 'protozoa' is given, are the causes of serious and ravaging diseases, and that the minute algoid plants, the bacteria, are not alone in possession of this field of activity. It was Laveran—a French medical man—who, just about twenty-five years ago, discovered the minute animal organism in the red blood-corpuscles, which is the cause of malaria. Year by year ever since our knowledge of this terrible little parasite has increased. We now know many similar to, but not identical with it, living in the blood of birds, reptiles and frogs.

It is the great merit of Major Ross, formerly of the Indian Army Medical Staff, to have discovered, by most patient and persevering experiment, that the malaria parasite passes a part of its life in the spot-winged gnat or mosquito (*Anopheles*), not, as he had at first supposed, in the common gnat or mosquito (*Culex*), and that if we can get rid of spot-winged mosquitoes or avoid their attentions, or even only prevent them from sucking the blood of malarial patients, we can lessen, or even abolish, malaria.

This great discovery was followed by another as to the production of the deadly 'Nagana' horse and cattle disease in South Africa by a screw-like, minute animal parasite, the *Trypanosoma Brucei*. The Tsetze fly, which was already known in some way to produce this disease, was found by

Colonel David Bruce to do so by conveying by its bite the Trypanosoma from wild big-game animals, to the domesticated horses and cattle of the colonists. The discovery of the parasite and its relation to the fly and the disease was as beautiful a piece of scientific investigation as biologists have ever seen. A curious and very important fact was discovered by Bruce—namely, that the native big game (zebras, antelopes, and probably buffaloes), are *tolerant* of the parasite. The Trypanosoma grows and multiplies in their blood, but does not kill them or even injure them. It is only the unaccustomed introduced animals from Europe which are poisoned by the chemical excreta of the Trypanosomes and die in consequence. Hence the wild creatures—brought into a condition of tolerance by natural selection and the dying out of those susceptible to the poison—form a sort of 'reservoir' of deadly Trypanosomes for the Tsetze flies to carry into the blood of newcomers. The same phenomenon of 'reservoir-hosts' (as I have elsewhere called them) has since been observed in the case of malaria; the children of the native blacks in Africa and in other malarious regions are *tolerant* of the malarial parasite, as many as 80 per cent. of children under ten being found to be infected, and yet not suffering from the poison. This is not the same thing as the immunity which consists in *repulsion* or *destruction* of the parasite.

The Trypanosomes have acquired a terrible notoriety within the last four years, since another species, also carried by a Tsetze fly of another species, has been discovered by Castellani in cases of sleeping sickness in Uganda, and demonstrated by Colonel Bruce to be the cause of that awful disease. More than 200,000 natives of Uganda have died from it within the last five years. It is incurable, and, sad to relate, not only a certain number of European employees have succumbed to it in tropical Africa, but a brave young officer of the Army Medical Corps, Lieutenant Tulloch, has died from the disease acquired by him in the course of an investigation of this disease and its possible cure, which he was carrying out, in association with other men of science, on the Victoria Nyanza Lake in Central Africa. Lieutenant Tulloch was sent out to this investigation by the Royal Society of London, and I will venture to ask you to join that body in sympathy for his friends, and admiration for him and the other courageous men who risk their lives in the endeavor to arrest disease.

Trypanosomes are now being recognized in the most diverse regions of the world as the cause of disease—new horse diseases in South America, in North Africa, in the Philippines and East India are all traced to peculiar species of Trypanosome. Other allied forms are responsible for Delhi-sore, and certain peculiar Indian fevers of man. A peculiar and ultra-minute parasite of the blood cells causes Texas fever, and various African fevers deadly to cattle. In all these cases, as also in that of plague, the knowledge of the carrier of the disease, often a mite or acarus—in that of plague the flea of the rat—is extremely important, as well as the knowledge of reservoir-hosts when such exist.

The zoologist thus comes into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease fully admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science they have cultivated

has become suddenly and urgently of the highest practical value.

I have not time to do more than mention here the effort that is being made by combined international research and cooperation to push further our knowledge of phthisis and of cancer, with a view to their destruction. It is only since our last meeting at York that the parasite of phthisis or tubercle has been made known; we may hope that it will not be long before we have similar knowledge as to cancer. Only eighteen months have elapsed since Fritz Schaudinn discovered the long-sought parasitic germ of syphilis, the *Spirochæta pallida*. As I write these words the sad news of Schaudinn's death at the age of thirty-five comes to me from his family at Hamburg—an irreparable loss.

Let me finally state, in relation to this study of disease, what is the simple fact—namely, that if the people of Britain wish to make an end of infective and other diseases they must take every possible means to discover capable investigators, and employ them for this purpose. To do this, far more money is required than is at present spent in that direction. It is necessary, if we are to do our utmost, to spend a thousand pounds of public money on this task where we now spend one pound. It would be reasonable and wise to expend ten million pounds a year of our revenues on the investigation and attempt to destroy disease. Actually, what is so spent is a mere nothing, a few thousands a year. Meanwhile our people are dying by thousands of preventable disease.

Whilst I have been able, though in a very fragmentary and incomplete way, to indicate the satisfactory and, indeed, the wonderful progress of science since this association last met in York, so far as the making of new knowledge is concerned, I am sorry to say that there is by no means a corresponding 'advancement' of science in that signification of the word which implies the increase of the influence of science in the life of the community, the increase of the support given to it, and of the desire to aid in its progress, to discover and then to encourage and reward those who are specially fitted to increase scientific knowledge, and to bring it to bear so as to promote the welfare of the community. I am speaking on a privileged occasion to a body of men who are met together for the advancement of science, and I claim the right to say to them, without offence to the representatives of institutions which I criticize, what is in my mind.

It is, unfortunately, true that the successive political administrators of the affairs of this country, as well as the permanent officials, are altogether unaware to-day, as they were twenty-five years ago, of the vital importance of that knowledge which we call science, and of the urgent need for making use of it in a variety of public affairs. Whole departments of government in which scientific knowledge is the one thing needful are carried on by ministers, permanent secretaries, assistant secretaries and clerks who are wholly ignorant of science, and naturally enough dislike it since it can not be used by them, and is in many instances the condemnation of their official employment. Such officials are, of course, not to be blamed, but rather the general indifference of the public to the unreasonable way in which its interests are neglected.

A difficult feature in treating of this subject is that when one mentions the fact that ministers of state and the officials of the public service are not acquainted with science, and do not even profess to understand its results or their importance, one's statement of this very obvious and notorious fact is apt to be regarded as a personal offence. It is difficult to see wherein the

offence lies, for no one seeks to blame these officials for a condition of things which is traditional and frankly admitted.

This is really a very serious matter for the British Association for the Advancement of Science to consider and deal with. We represent a line of activity, a group of professions which are, in our opinion, of vital importance to the well-being of the nation. We know that those interests which we value so highly are not merely ignored and neglected, but are actually treated as of no account or as non-existent by the old-established class of politicians and administrators. It is not too much to say that there is a natural fear and dislike of scientific knowledge on the part of a large proportion of the persons who are devoid of it, and who would cease to hold, or never have held, the positions of authority or emolument which they now occupy, were scientific knowledge of the matters with which they undertake to deal required of them. This is a thorny subject, and one in which, however much one may endeavor to speak in general terms, it is difficult to avoid causing personal annoyance. Yet it seems to me one which, believing as I do that it is of most urgent importance, it is my duty as your president to press upon the attention of the members of the British Association. Probably an inquiry into and discussion of the neglect of science and the questionable treatment of scientific men by the administrative departments of government would be more appropriate to a committee appointed by the council of the association for this purpose than to the presidential address.

At the same time, I think the present occasion is one on which attention should be drawn in general terms to the fact that science is not gaining 'advancement' in public and official consideration and support. The reason is, I think, to be found in the defective education, both at school and university, of our governing class, as well as in a racial dislike among all classes to the establishment and support by public funds of posts which the average man may not expect to succeed by popular clamor or class privilege in gaining for himself—posts which must be held by men of special training and mental gifts. Whatever the reason for the neglect, the only remedy which we can possibly apply is that of improved education for the upper classes, and the continued effort to spread a knowledge of the results of science and a love for it amongst all members of the community. If members of the British Association took this matter seriously to heart they might do a great deal by insisting that their sons, and their daughters too, should have reasonable instruction in science both at school and college. They could, by their own initiative and example, do a good deal to put an end to the trifling with classical literature and the absorption in athletics which is considered by too many schoolmasters as that which the British parent desires as the education of his children.

* * * * * * *

It is more agreeable to me not to dwell further on the comparative failure of science to gain increased influence and support in this country, but to mention to you some instances on the other side of the account. As long ago as 1842 the British Association took over and developed an observatory in the Deer Park at Kew, which was placed at the disposal of the association by Her Majesty the Queen. Until 1871 the association spent annually a large part of its income—as much in later years as £600 a year—in carrying on the work of the Kew Observatory, consisting of magnetic, meteorological and physical observations. In 1871 the association handed over the observatory to the Royal Society, which

had received an endowment of £10,000 from Mr. Gassiot for its maintenance, and had further devoted to that purpose considerable sums from its own donation fund and government grant. Further aid for it was also received from private sources. From this observatory at last has sprung, in the beginning of the present century, the National Physical Laboratory in Bushey Park, a fine and efficient scientific institution, built and supported by grants from the state, and managed by a committee of really devoted men of science who are largely representatives of the Royal Society. In addition to the value of the site and buildings occupied by the National Physical Laboratory, the government has contributed altogether £34,000 to the capital expenditure on new buildings, fittings and apparatus, and has further assigned a grant of £6,000 a year to the working of the laboratory. This institution all men of science are truly glad to have gained from the state, and they will remember with gratitude the statesmen—the late Marquis of Salisbury, the Right Hon. Arthur J. Balfour, Mr. Haldane and others—as well as their own leaders—Lord Rayleigh, Sir William Huggins and the active body of physicists in the Royal Society—who have carried this enterprise to completion. The British Association has every reason to be proud of its share in early days in nursing the germ at Kew which has at length expanded into this splendid national institution.

I may mention also another institution which, during the past quarter of a century, has come into existence and received, originally through the influence of the late Lord Playfair (one of the few men of science who have ever occupied the position of a minister of the crown), and later by the influence of the Right Hon. Joseph Chamberlain, a subsidy of £1,000 a year from the government and a contribution of £5,000 towards its initial expenses. This is the Marine Biological Association, which has a laboratory at Plymouth, and has lately expended a special annual grant, at the spontaneous invitation of His Majesty's Treasury, in conducting an investigation of the North Sea in accordance with an international scheme devised by a central committee of scientific experts. This scheme has for its purpose the gaining such knowledge of the North Sea and its inhabitants as shall be useful in dealing practically and by legislation with the great fisheries of that area. You will, perhaps, not be surprised to hear that there are persons in high positions who, though admittedly unacquainted with the scientific questions at issue or the proper manner of solving them, are discontented with the action of the government in entrusting the expenditure of public money to a body of scientific men who give their services, without reward or thanks, to carrying out the purposes of the international inquiry. Strange criticisms are offered by these malcontents in regard to the work done in the international exploration of the North Sea, and a desire is expressed to secure the money for expenditure by a less scientific agency. I do not hesitate to say here that the results obtained by the Marine Biological Association are of great value and interest, and, if properly continued and put to practical application, are likely to benefit very greatly the fishery industry; on the other hand, if the work is cut short or entrusted to incompetent hands it will no doubt be the case that what has already been done will lose its value—that is to say, will have been wasted. There is imminent danger of this perversion of the funds assigned to this scientific investigation taking place. There is no guarantee for the continuance of any funds or offices assigned to science in one generation by the officials of the next. The mastership of

the mint held by Isaac Newton, and finally by Thomas Graham, has been abolished and its salary appropriated by non-scientific officials. Only a few years ago it was with great difficulty that the government of the day was prevented from assigning the directorship of Kew Gardens to a young man of influence devoid of all knowledge of botany!

One of the most solid tests of the esteem and value attached to scientific progress by the community is the dedication of large sums of money to scientific purposes by its wealthier members. We know that in the United States such gifts are not infrequent; they are rare in this country. It is, therefore, with especial pleasure that I call your attention to a great gift to science in this country made only a few years ago. Lord Iveagh has endowed the Lister Institute, for researches in connection with the prevention of disease, with no less a sum than a quarter of a million pounds sterling. This is the largest gift ever made to science in this country, and will be productive of great benefit to humanity. The Lister Institute took its origin in the surplus of a fund raised by Sir James Whitehead when Lord Mayor, some sixteen years ago, for the purpose of making a gift to the Pasteur Institute in Paris, where many English patients had been treated, without charge, after being bitten by rabid dogs. Three thousand pounds was sent to M. Pasteur, and the surplus of a few hundred pounds was made the starting-point of a fund which grew, by one generous gift and another, until the Lister Institute on the Thames Embankment at Chelsea was set up on a site presented by that good and high-minded man, the late Duke of Westminster.

Many other noble gifts to scientific research have been made in this country during the period on which we are looking back. Let us be thankful for them, and admire the wise munificence of the donors. But none the less we must refuse to rely entirely on such liberality for the development of the army of science, which has to do battle for mankind against the obvious disabilities and sufferings which afflict us and can be removed by knowledge. The organization and finance of this army should be the care of the state.

It is a fact which many of us who have observed it regret very keenly, that there is to-day a less widespread interest than formerly in natural history and general science, outside the strictly professional arena of the school and university. The field naturalists among the squires and the country parsons seem nowadays not to be so numerous and active in their delightful pursuits as formerly, and the mechanics' institutes and lecture societies of the days of Lord Brougham have given place, to a very large extent, to musical performances, bioscopes and other entertainments, more diverting, but not really more capable of giving pleasure than those in which science was popularized. No doubt the organization and professional character of scientific work are to a large extent the cause of this falling-off in its attraction for amateurs. But perhaps that decadence is also due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centers of fashionable amusement to the provinces and rural districts.

In conclusion, I would say a word in reference to the associations of our place of meeting, the birthplace of our society. It seems to me not inappropriate that a society for the advancement of science should have taken its origin under the walls of York Minster, and that the clergy of the great cathedral should have stood by its cradle. It is not true that there is an essential antagonism between the scientific

spirit and what is called the religious sentiment. "Religion," said Bishop Creighton, "means the knowledge of our destiny and of the means of fulfilling it." We can say no more and no less of science. Men of science seek, in all reverence, to discover the Almighty, the Everlasting. They claim sympathy and friendship with those who, like themselves, have turned away from the more material struggles of human life, and have set their hearts and minds on the knowledge of the Eternal.

THE ITHACA MEETING OF THE AMERICAN CHEMICAL SOCIETY. II.

SECOND GENERAL SESSION.

At the second general session the following addresses were given:

Hydronitric Acid: L. M. Dennis.

Recent Progress in Industrial Chemistry: J. D. Pennock.

The address first cites the rapid progress of the ammonia soda process in comparison with the Le Blanc, showing that from 1870 to 1903 the world's production of soda by the ammonia process increased from 2,600 to 1;150,000 tons per annum, and the Le Blanc process decreased from 447,000 in 1870 to 150,000 in 1903. The reason for the continuance of industrial life in the Le Blanc works is the income obtained from bleaching powder and sulphur products. The progress of the electrolytic process is then discussed and a statement is made that in 1905 considerable profit was made by at least two concerns in England on the manufacture of electrolytic caustic soda and bleaching powder. Comment was made on the development of the treatment of fatty acids by carbonate of soda in the manufacture of soap, rather than the old method of treating neutral fats with caustic soda and thereby making a considerable saving. It was predicted that the tendency in industrial operations to the use of fuel gas from coke ovens and producers will ultimately do away with the smoke nuisance. The utilization of peat for producer gas and in the making of crude paper are interesting developments along this line. The introduction of alcohol free from tax after January 1, 1907, will call for a denaturizing substance of some sort. Doubtless the United States will follow the German practise of using a 2.5 per cent. solution made up of four liters of wood alcohol and one liter of pyridine added to 100 liters of alcohol. The future source of suitable nitrogen for the soil was then discussed. First dealing with Dr. Frank's calcium cyanimide process, then with Birkland and Eydes fixation of atmospheric nitrogen, and with the immediate and more practical application of ammonium sulphate manufactured on a large scale by the by-product coke ovens. It was predicted that in about thirty years the supply of nitrate of soda will be exhausted. The source of nitrogen must then be furnished by one of the above described processes.

Some Problems of Biological Chemistry: Waldemar Koch.

It was pointed out that it is possible to investigate a tissue from the point of view of a chemist without isolating definite chemical substances, by dividing the constituents into the following groups: proteids, carbohydrates, fats, lecithins, extractives, ash. These groups have a physiological significance and the distribution among them of definite substances or elements like phosphorus, which was especially discussed, can vary in some of these groups within wide limits under different physiological conditions. The possibility of determining the physiological value of the different combinations of phosphoric acid to the cell was illustrated by a number of examples.

INORGANIC CHEMISTRY.

L. M. Dennis, Chairman.

Some New Compounds of Thallium: L. F. HAWLEY.

Three new compounds of thallium were described: thallium fulminate, $Tl_2C_2N_2O_2$, thallium aluminate, $Tl_4Al_2O_5 . 2H_2O$, and potassium thallic chromate, $K_2CrO_4 . Tl_2(CrO_4)_3 . 4H_2O$.

Experiments upon the Radium Emanation: L. F. HAWLEY.

With the idea in view that the rare atmospheric gases might be the activizing agents of radioactive bodies an attempt was made to find whether the atmosphere produced any effect on the emanations from radium. A water solution of radium chloride was kept in an atmosphere of hydrogen entirely free from the atmospheric gases, and the emanations produced during several three-day periods were measured by bubbling the pure hydrogen through the solution and leading the hydrogen and emanation into a measuring tube connected with an electrometer. Then similar measurements were made under exactly the same conditions except that air was used in the place of the hydrogen. No difference was found except that due to the difference in the absorption of the radiations by the hydrogen and the air.

On the Reaction between Hydrazine Sulphate and Potassium Chlorate: A. W. BROWNE.

This reaction does not proceed in presence of sulphuric acid entirely in accordance with the general equation for the oxidation of hydrazine sulphate as given by Roberto and Roncali:

$$N_2H_4 . H_2SO_4 + 2O = N_2 + 2H_2O + H_2SO_4.$$

Three series of experiments have been made, from which it is evident that the reaction takes place very largely as expressed by the following equation:

$$4N_2H_4 . H_2SO_4 + 4O = 2HN_3 + (NH_4)_2SO_4 + 3H_2SO_4 + 4H_2O.$$

Within certain limits the yield of HN_3 varies directly with the amount of H_2SO_4 present and inversely with the excess of $KClO_3$. Under favorable conditions the yield amounts to over 23 per cent. of theory according to the above equation.

A Modified Hydrogen Sulphide Generator: A. W. BROWNE and M. F. MEHLING.

The apparatus is essentially a modified Ostwald gas generator capable of furnishing hydrogen sulphide in quantities sufficient to supply a class of 275 students. The supply of acid (1:1 HCl) and the discharge of the thoroughly neutralized spent acid is automatically regulated by a method somewhat similar in principle to that employed in the Parsons apparatus.

On the Analysis of Silver Trinitride: L. M. DENNIS and A. W. BROWNE. (By title.)

Colorimetric Determination of Iron with special reference to Purity of Reagents: H. N. STOKES and J. R. CAIN.

The interfering action of large amounts of acids or salts is avoided by concentrating the iron, either by evaporation in the case of easily volatile substances or by carrying down as hydroxide by manganese dioxide (reduced from permanganate) or as sulphide by cadmium sulphide. After suitable treatment it is dissolved in free sulphocyanic acid saturated with mercuric sulphocyanate, and after adding a little persulphate is extracted with amyl alcohol in the colorimeter cylinder, the duplicate cylinder containing the same volume of sulphocyanic acid and amyl alcohol. Less than 0.001 mg. iron may thus be detected in 50 grams of a non-volatile salt.

Beryllium Carbonate: CHARLES L. PARSONS and EDWIN J. ROBERTS.

Normal beryllium carbonate can not be

made at ordinary pressures in contact with water. $BeCO_4 + 4HO$ described by Klatzo does not exist, and attempts to make it by his method yield only slightly carbonated hydroxide. Basic beryllium carbonate appears to have no definite composition and can be almost completely converted into the hydroxide by boiling in water. All attempts to increase the proportion of the CO_2 components over the proportion $2Be(OH)_2 . BeCO_3$ failed, although CO_2 was passed for three months through the basic carbonate under slightly increased pressure. The basic carbonates described in literature must have contained at least one or two per cent. of the carbonate used as a solvent or precipitant.

The Separation and Estimation of Beryllium: Chas. L. Parsons and Stuart R. Barnes.

Beryllium is separated from aluminum and iron by the complete solubility of its hydroxide in a hot saturated solution of acid sodium carbonate—ferric hydroxide and aluminum hydroxide being completely insoluble. Double precipitation is essential. Beryllium hydroxide must be washed with water containing an electrolyte in solution, for when pure it rapidly washes through the filter in a colloidal condition. Sodium acetate used in this manner gave excellent results.

The Elementary Nature of Tellurium: J. F. Norris.

On account of the fact that the atomic weight of tellurium is inconsistent with its position in the family which contains sulphur and selenium in the periodic classification of the elements, the author undertook a series of experiments to determine whether tellurium contains an undiscovered element. In order to free the tellurium from any element which does not belong to the sulphur family, it was converted into the compound $Na_2S_4TeO_6$, and from this derivative of sodium pentathionate, the tellurium was separated. In order to determine whether the element contained another element in the sulphur family, with an atomic weight higher than that of tellurium, a sample of carefully purified telturium dioxide was subjected to fractional sublimation. Atomic weight determinations were made of the element in the various fractions as well as of that in the unsublimed oxide and of the tellurium prepared from the derivative of the sodium pentathionate. The result was the same in all cases, namely, 127.6. The work establishes more definitely than has been done heretofore the elementary nature of tellurium.

On the Mercuri-ammonium Salts and Bases: E. C. Franklin.

It will be shown in this paper that the so-called mercuri-ammonium salts are not substituted ammonium salts at all, but are to be classified under the three heads as (1) mercury salts with ammonia of crystallization, (2) ammoni-basic mercuric salts, and (3) mixed hydro-basic ammono-basic mercuric salts. For example, the fusible white precipitate is mercuric chloride with ammonia of crystallization, $HgCl_2 . 2NH_3$, and not mercuri-diammonium chloride, $Hg(NH_3)_2Cl_2$, the infusible white precipitate is ammono-basic mercuric chloride, NH_2HgCl, a compound related to ammonia as the ordinary basic salts are related to water and is not mercuri-ammonium chloride, $HgNH_2Cl$, while the chloride of Millon's base is a salt basic both to ammonia and water and is not oxydimercuri-ammonium chloride nor yet a hydrated dimercuri-ammonium chloride.

Potassium Ammono-zincate: E. C. Franklin and F. F. Fitzgerald.

Recalling the analogy between liquid ammonia and water as electrolytic solvents as emphasized in earlier papers by Frank-

lin and his co-workers, the authors have shown that potassium amide acts upon metallic zinc and upon zinc amide in liquid ammonia in a manner analogous to the well-known action of potassium hydroxide on metallic zinc and zinc hydroxide in aqueous solution. The ammono-potassium zincate, $Zn(NHK)_2$, analogous to the oxygen compound formed in aqueous solution, has been prepared. Other compounds belonging to this class undoubtedly exist, but have not yet been satisfactorily isolated.

Liquid Methylamine as a Solvent: H. D. GIBBS.

A consideration of the many analogies between water and liquid ammonia as electrolytic solvents has led to a study of methylamine which, formally related to ammonia as methyl alcohol is related to water, might be expected to exhibit interesting properties. It has been found to possess very wide solvent power; it unites with many inorganic salts and organic compounds as methylamine of crystallization, and it gives solutions with certain salts which exhibit unique conductivity curves.

Hydronitric Acid: L. M. DENNIS and HELEN ISHAM.

Anhydrous hydronitric (HN_3) was prepared by treating crystalline KN_3 with sulphuric acid (2:1). The dried gas was solidified by means of liquid air. Its melting-point is $-80°$. The boiling-point of the liquefied acid is 37°. The determination of the vapor density by the Victor Meyer method showed that at a temperature about 25° above its boiling-point the acid possesses the molecular formula HN_3. Several new salts of the acid were prepared and studied. The reaction between dry hydronitric acid and dry hydrochloric acid was carefully examined and found to proceed according to the equation

$$3HN_3 + HCl = NH_4Cl + 4N_2.$$

INDUSTRIAL CHEMISTRY.

J. D. Pennock, Chairman.

Notes on the Use of Peat: CULLEN W. PARMELEE.

A restatement of some phases of the peat industry of especial interest to the agricultural chemist with particular reference to the use of it as a filler in fertilizers. The average nitrogen of 123 samples of New Jersey peats analyzed in the writer's laboratory is reported as 1.75 per cent.

A Review of the American Cement Manufacture: R. K. MEADE.

Experiments made at Sault Ste. Marie, Ont., under the Auspices of the Canadian Government, in the Smelting of Iron Ores by the Electrothermic Process: Dr. EUGENE HAANEL.

In this paper Dr. Haanel points out the importance of the electric smelting process, especially for countries possessing water-powers and ore deposits, but lacking coal for metallurgical use, and gives a description of the plant erected and experiments conducted at Sault Ste. Marie, with a view of ascertaining several important items, which could not be obtained by the commission previously appointed by the Canadian government. (The report of this commission was published in 1904 by the Mines Branch of the Interior Department, Ottawa.)

The following is a summary of the results of the experiments: (1) Magnetite can be as economically smelted by the electro-thermic process as hematite. (2) Ores of comparatively high sulphur content can be made into pig iron containing only a few thousandths of a per cent. of sulphur. (3) The silicon content can be varied as required for the class of pig to be produced. (4) Charcoal which can be cheaply produced from mill refuse or wood which could not otherwise be utilized and peat-coke can be substituted for coke as re-

ducing agent. (5) A ferro-nickel pig can be produced practically free from sulphur from roasted nickeliferous pyrrhotite. (6) Titaniferous iron ores containing up to 5 per cent. of titanic acid can be successfully treated. (7) Under normal conditions an expenditure of 1,000 E.H.P. days is required for an output of twelve tons of pig iron.

Classification of Coals: S. W. Parr.

The classification proposes to proceed on the basis of the old nomenclature offered by Frazier, but it bases the distinctions upon data of a different sort. The main divisions in the classification are made to depend upon the ratio of the volatile carbon to the total carbon, and by volatile carbon is meant not the volatile matter as that term is sometimes erroneously applied, but the carbon part of the hydrocarbon constituents as indicated by the difference between total carbon and fixed carbon. This leads directly to a further factor, namely, that part of volatile matter which is inert and non-combustible, and this constituent is made to indicate the further subdivision in the bituminous coals proper, and between the bituminous coals and the lignites, as well as between the different forms of lignites themselves. The method of classification was illustrated by making use of the complete analytical results from over one hundred samples of coal selected from representative fields throughout the United States.

Salt in the State of New York, its History, Resources and Manufacture: F. E. Engelhardt.

The presence of salt in the state of New York is first recorded in the so-called 'Relations of the Jesuit Fathers,' by Father Jerome Lallemant and Father Charlevoix, 1645–6. First salt made by Father Simon LeMoyne in August, 1653. Practical manufacture of salt begun at Syracuse in 1788. The Indians ceded to the state of New York their land in the treaty at Fort Schuyler, 1788, except the lake and the lands for one mile round it, and in the treaty at Cayuga Ferry, 1795, they ceded this and a strip one half mile wide on the west side of Onondaga Creek from their village to the lake, about six miles long. The legislature of the state passed its first law regulating the manufacture of salt in 1797.

The manufacture of solar salt was begun in 1821, and in the same year Major B. Boyington sunk a well 300 feet deep for rock salt, without results. Wells were first square holes, about 30 feet deep by 20 feet wide, followed by cast-iron tubing of 8-inch bore; next came wooden tubing, and for the last fifty years wells have been tubed with 6- and 8-inch wrought-iron pipes. Wood was first employed as fuel, then semi-bituminous coal, and lately anthracite coal-dust with artificial draft. About 50 bushels of salt (of 56 pounds each) is the average result with good dust and brine of 68 salometer at 60° F. Largest amount of salt was produced in 1862, namely, 9,053,874 bushels. Total production up to date at Syracuse, about 433 million bushels, or over 12 million tons.

Salt is made in the state by artificial means, as in the kettle or Onondaga method, at Syracuse. In the western part of the state salt is made in the open pan, in grainers (the Michigan system) and in the vacuum pan. By solar heat in shallow wooden vats with movable wooden covers to protect them against rain. Their capacity is greatly increased by the so-called 'salt aprons.' This method is only practised at Syracuse. The total salt production of the state amounted, in 1905, to about 5,435,005 barrels of 280 pounds, or 5 bushels, each.

Rock salt was first discovered on June 20, 1878, in Wyoming County, on the farm

of Mr. Matthews, at a depth of 1,270 feet. The bed was 70 feet in thickness. The first shaft for mining the rock salt was finished in 1885. It is situated near Piffard, Livingston County, and is 1,018 feet deep. It is called the Retsof shaft. The Greigsville shaft is about one mile south of the former. The third shaft is two miles south of LeRoy and has a depth of 825 feet, and the fourth shaft was sunk at Livonia, Livingston County, to a depth of 1,430 feet. But one mine, the 'Retsof,' is at present operated.

All the salt wells of the state without exception, as well as these four salt shafts, obtain their brine or salt from one and the same rock-salt deposit, situated in the 'Upper Silurian.' It extends from Morrisville, Madison County, to Lake Erie, and from LeRoy to Watkins. The salt stratum is over 100 feet in thickness, depending entirely upon the configuration of the ground below the Silurian sea at the time of its formation. The rock salt occurs in one vein, two, three, four, five, six or even seven veins of various thickness and depth from the surface of the ground. The dip of the rock is southwest, about 41 to 46 feet.

The Solvay Process Company, after three attempts, finally obtained rock salt almost directly under the Tully Hills, which are 300 feet above, and has at present 51 wells, 30 on the east side, and 21 on the west side, of the Onondaga Valley, which at the present time supplies them with the brine required for the manufacture of soda ash, caustic soda, baking soda, etc.

Sources of Some Common Impurities in C. P. Chemicals: JAMES W. SCHADE.

The object of this paper is to present the sources of impurities in chemical reagents and to show that there are limits to the purity obtainable by manufacturers. The sources of impurities are: (1) the containers in which chemicals are shipped; (2) tanks, stills, condensers, and so on, in which chemicals are made; (3) reagents used to precipitate certain impurities or compounds formed by these reactions; (4) minerals from which the chemicals are made and materials used in manufacture. The danger of contamination by impurities of the first two classes may be minimized by careful selection of material for containers and apparatus. The presence of both barium and sulphate in a sample of sodium chloride and of calcium in ammonium oxalate are examples of impurities of the third class. Impurities of the fourth class are illustrated by the persistence of calcium in barium compounds and the constant association of nickel and cobalt in their purified salts. For ordinary work, however, reagents that will give accurate results can be manufactured at a reasonable cost.

On the Determination of Carbon Disulphide and Total Sulphur in Commercial Benzol: EDWARD S. JOHNSON.

(1) *The Determination of Carbon Disulphide.*—The principle underlying the method seemingly most widely applied is that of the transformation of carbon disulphide by means of alcoholic potash[1] into potassium xanthate, utilizing this substance as a medium for separation. For determination the potassium compound is best converted into cuprous xanthate and the latter into CuO. Much uncertainty exists apparently as to the exact composition of the so-called cuprous xanthate. If constituted as represented by the formula $(CS.OC_2H_5S)_2Cu_2$, the ratio of CuO produced to CS_2 entering into the formation of the xanthate should be 1.0:0.9563. Macagno[2] found 1.0:1.931, a little more than *twice* the theoretical. Others have obtained similar results. As evidently cuprous xanthate is not the compound under consideration, an investigation seemed

[1] Nickels, *Chem. News*, 43, 148.

[2] *Chem. News*, 43, 138.

desirable, and the more so because of a strong probability of a variation in composition with changing conditions of formation. Experiments were, therefore, made, operating with known quantities of carbon disulphide dissolved in pure benzol, to ascertain the desired *ratio under given, easily-realized conditions.* An average of 1.0:1.750 was found. The factors most strongly influencing the ratio, as far as studied, are size of the xanthate precipitate (the CS_2 present) and the time of its exposure to the mother liquors. By adhering to definite conditions very satisfactory analytical results are obtainable.

(2) *Determination of Total Sulphur in Benzol.*—The determination is accomplished by volatilization of the sample in a current of hydrogen and combustion of the vapors in an atmosphere of oxygen. The products of combustion are passed into a suitable absorption medium and the sulphur determined by familiar methods. A new *form of apparatus* for the combustion is described. The essential feature is the vertical combustion tube, 35 mm. in diameter and 170 mm. long. This is supplied with oxygen at the upper end, the products of combustion leaving at the bottom. The vapors are admitted by the burner-tube inserted through a horizontal arm in the center of the tube. Diametrically opposite is a similar arm carrying a pilot-flame tube. The flame, of hydrogen, is placed close to the burner-tip and serves to ignite the vapors at once upon their arrival, and further permits, evidently, the reestablishment of the combustion should it be accidentally or necessarily interrupted for a few moments. About 5 grams of benzol may be burned in three hours. Entirely satisfactory determinations were found possible. Samples with as much as 5 per cent. CS_2, and doubtless more, are readily handled with success. Insuring perfect and convenient combustion, the apparatus could be extended in its application to gases and vapors of whatever description. Fuel and illuminating gases are here in mind. It could further doubtless be made to lend itself in many instances advantageously to sulphur determinations in the ultimate analysis of organic compounds.

The Technical Determination of Benzol in Illuminating Gas: D. A. Morton.

Examination of the method of Dennis and O'Neill for the determination of benzene in illuminating gas (*Jour. Amer. Chem. Soc.*, 1903, p. 503) shows that the results are low, and unless the reagent be freshly prepared for each test, not even approximately correct. Moreover, the absorbent (ammonium nickel nitrate solution) dissolves benzene only to the same extent as pure water, showing that the presence of nickel compound has no influence. As a practical method for the determination of benzol in coal gases, absorption by means of concentrated sulphuric acid is recommended. By the use of this reagent a good separation of benzol from ethylene is effected.

BIOLOGICAL CHEMISTRY.

Waldemar Koch, Chairman.

The Phosphorous Content of Feces Fat: J. H. Long.

It is stated in many works on physiological chemistry that lecithins and similar bodies are either absent or present only in traces in the fat extracted from feces. In a previous paper the author pointed out that an organic phosphorous compound of the lecithin type may be sometimes present in relatively large amounts. In the present paper the results are given of the analyses of feces fat from seven individuals in which the phosphorous content was found to vary within wide limits. This phosphorus was in organic combination and apparently in a

body of the lecithin type. Some statements are made of the possible sources of the lecithins in feces.

Dissociable Compounds of Mucoids and other Proteins: W. J. GIES.

We know practically nothing about the ways in which proteins are held in living protoplasmic structures. The molecules of the protein compounds are relatively so large that as yet our physico-chemical methods of measurement are inadequate to give us correct ideas of molecular size and intramolecular structure, although we know much about the lifeless and, in some respects, comparatively meaningless fragments into which protein molecules may be broken. Our ignorance of the fundamental biochemical relation of proteins to the associated constituents of protoplasm appears to be largely due to our vague knowledge of the chemical statics and dynamics of true cellular proteins, a fact which serves, however, as a constant stimulus to protein investigation. Among the many protein substances, the nucleoproteins and the glucoproteins are very important tissue constituents. The essential part of each of these natural type proteins and the part to which the usual name is applied appears to be a colloidal organic acid. The forms in which the acid radicals occur in cells and tissues have not been definitely made out, although it is natural to presume that the acid radicals are united directly to one or more distinctly basic radicals in each case, and that variations in the characters of such compounds are associated with physiological as well as pathological variations of cellular composition and tissue function. The author has attempted to get to the bottom of this complicated matter by making definite salts of these proteins with the aid of methods that could be relied upon to leave the acid radicals unchanged.

The writer has lately prepared calcium, sodium, potassium and ammonium salts of mucoid by the following process: The slightly alkaline solution of glucoprotein is dialyzed until neutral and then poured into a large excess of 95 per cent. alcohol, which causes the precipitation of the mucoid. This precipitate is purified by resolution, dialysis and reprecipitation. The final product is made anhydrous by treatment with absolute alcohol and ether. The comparatively pure salts thus obtained are light snow-white powders.

The author hopes that, by increasing the knowledge of artificial products, analogies with natural compounds would be not only more easily recognized but also the characters of functions of the compounds in living protoplasm would be more thoroughly understood.

G. R. WHITE,
Press Secretary.

SCIENTIFIC BOOKS.

Leitfaden für den praktisch-chemischen Unterricht der Mediziner. Zusammengestellt von FRANZ HOFMEISTER, Professor der physiologischen Chemie an der Universität Strassburg. II. Aufl. Braunschweig, Viewig u. Sohn. 1906. Pp. 136. Preis Mark 3.50.

This little book admirably describes laboratory courses in qualitative analysis, organic chemistry (so far as it may be of interest to the physician) and in physiological chemistry. The directions given for making tests are brief and precise and at many places reasons are given for the methods advised in making the tests. In this revision it appears that particular attention was given to the course in physiological chemistry so that it might include the results of the latest investigations bearing especially upon the tests for the substances concerned in that branch of science. In short, the book is one which excellently covers the ground in practical chemistry essential to medical students.

JOHN MARSHALL.

SCIENTIFIC JOURNALS AND ARTICLES.

The leading article in the August number of the *Journal of Nervous and Mental Disease* is Dr. Stedman's address as president of the American Neurological Association. His subject was 'The Public Obligations of the Neurologist,' and he urged the establishment of charitable sanitaria for the care of the poor who suffered from nervous diseases. He spoke of the fading out of the division between psychiatry and neurology, and the advance of the treatment of mental disorders by mental and moral methods. He also emphasized the importance of public provision for the after care of patients discharged from the state hospitals, and urged the removal of the feeble-minded to separate colonies. Drs. Spiller and Weisenburg contribute the report of eleven cases of carcinoma involving the nervous system, with a number of illustrations. Dr. Burr follows with a note on the temporary disappearance of the sensory symptoms in syringomyelia, and Dr. Martin adds a short study of the sphincter reflexes in tabes dorsalis and paresis.

The *Annals of Iowa* for July, 1906, a magazine published quarterly by the State Historical Department at Des Moines, contains an appreciative biographical memoir of the late Dr. C. C. Parry, by Dr. Charles A. White. This memoir thus becomes a part of the state archives.

DISCUSSION AND CORRESPONDENCE.

THE PRIMARY SEPTA IN RUGOSE CORALS.

In Science, June 30, 1905, there appears an abstract of a paper, 'Early Stages of some Paleozoic Corals,' read by Mr. C. E. Gordon before the New York Academy of Sciences. The abstract is mainly a criticism of my paper, 'Relationships of the Rugosa (Tetracoralla) to the living Zoantheæ,' 1902. Having delayed a reply until the publication of the complete contribution,[1] I am now in a better position to estimate the value of the evidence upon which the author's assertions are based. A full discussion, with additional evidence in support of my contentions, will appear later, but in the meantime the importance of the subject calls for a brief statement.

The greater part of Gordon's final paper is devoted to a demonstration that the septal arrangement in *Lophophyllum proliferum*, the form studied by me, can be brought into agreement with the usually accepted septal plan of zaphrentoid corals, a fact upon which there could possibly be no divergence of opinion. To accomplish this he reproduces most of my figures, but in an inverted manner, and then shows how they agree with the septal plan of a zaphrentoid coral as represented by a schematic figure taken from Kunth, 1869–70. In the course of this Gordon corrects a confusion of mine, corrected elsewhere, in which I transpose the terms cardinal and counter septa; apparently, however, he does not realize the difference in the septal plan as established from the external ridges and grooves and that from the disposition of the septa within the calice.

In inverting my figures Gordon is altogether at variance with every recent worker on the Zoantharia. The dorso-ventral disposition of Kunth's schematic figure was given before much was known of the morphology and relationships of the Zoantharia. It would have been much easier and displayed a wider appreciation of recent work on the subject if Gordon had inverted his own figure and allowed the others to retain the orientation originally given them.

The main contention of the paper centers in the number of primary septa (protosepta) in the Rugosa, whether four or six. The great importance for phylogenetic purposes of a correct determination of this demands that Gordon's remarks and evidence should be submitted to thorough analysis. In my paper on *Lophophyllum proliferum* I showed that this species has six primary septa, thereby confirming the account of Pourtalès in 'Deep Sea Corals.' Gordon does not question this hexamerism, but attempts to explain it as a case of acceleration; according to his idea four primary septa were originally present, but the time of appearance of a third pair has been hastened so as to give six primary septa. No facts nor valid arguments are adduced in

[1] *Amer. Jour. Science*, February, 1906.

support of this purely hypothetical acceleration; much is made of a suggestion that acceleration is likely to occur because *Lophophyllum* appears late (Carboniferous) in the geological history of the Rugosa. The author then produces what he considers evidence in favor of a primary tetrameral plan. This rests entirely upon a decalcified silicified specimen of *Streptelasma profundum* (Owen) in which no doubt was left in the author's mind that four of the strongest septa extended farthest down into the base of the calice. No sections are given, and no other suitable material seems to have been at command.

I, likewise, have in my possession numerous decalcified silicified specimens of *S. profundum,* the septal plan of one of which is figured in *Biol. Bull.,* June, 1905, p. 39. Some of these are beautifully perfect, and present all the appearances described by Gordon, but one would scarcely think of using mere surface views for the determination of a question of such fundamental importance, especially when more reliable means are available. Since the publication of my paper in 1902 I have made special efforts, with the assistance of grants from the Carnegie Institution, to secure from all parts typical species of the Rugosa with perfect tips suitable for the investigation of this particular problem. Any one familiar with the subject knows how very rare such specimens are and the difficulties which surround their examination. From my study of these, by the method of grinding, I can now state that *in five different species I have definitely determined the presence of six primary septa,* all equal, and situated at equal distances apart. These species are *Streptelasma rectum* Hall, already figured in *Biol. Bull.,* June, 1905, *Cyathaxonia cynodon* E. & H., *Hadrophyllum glans* (White), *Hadrophyllum pauciradiatum* E. & H., and *Microcyclus discus* Meek & Worthen. Many other species have been investigated, but for one reason or another their tips were unfavorable for showing the primary septa, yet in tracing the development of the later septa this so closely agreed with the species mentioned that there can be no reasonable hesitation in assuming that their primary septa were hexameral. In no instance were there only four protosepta.

Thus, with the addition of *Lophophyllum proliferum,* the hexamerism of which Gordon does not dispute, there are now six known species of Rugosa each having six primary septa, while not a single undoubted instance of only four primary septa has been brought forward. Moreover, the geological distribution of the species mentioned is so wide, from the earliest to the latest appearance of the Rugosa, that Gordon's main argument in favor of acceleration fails in its application. Unless, therefore, fresh and weighty evidence to the contrary should be forthcoming we are reasonably justified in considering the primary hexamerism of the Rugosa as established.

The underlying significance of the primary hexamerism of the Rugosa is that it admits of the relationship of the group with other Anthozoa being established. In the past the assumed tetramerism has led to many fanciful suggestions. In my original paper I showed conclusively that the Rugosa find their nearest modern relatives among the zoanthid actinians, and subsequent work, especially on the fossula, has but served to confirm this. Unless Gordon can produce more acceptable evidence than is contained in his paper under review his contribution must be regarded as a retrograde step in our efforts to determine the phylogenetic relationships of the Rugosa.

J. E. DUERDEN.

RHODES UNIVERSITY COLLEGE,
GRAHAMSTOWN, CAPE COLONY.

THE SOURCE OF THE ENERGY OF CYCLONES.

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE of May 5 last you were good enough to publish a communication of mine suggesting the source of origin of cyclones, cold waves, and tornadoes. Since the appearance of that article there has occurred to me the suggestion of the derivation of the energy involved in the movement of these bodies, or I might better say, a mechanism of the action of the prevailing westerly winds in accomplishing their movement, that has not hitherto been suggested by any one, as far as I know.

When a cyclone has once been inaugurated, in whatever way this may be effected, it presents itself as a mountain of air with a tendency to rise to a great height into the prevailing over-current. If established before starting on its journey, there was an inrush of air from every direction, and to the extent of the momentum of this inrush the mountain was a hollow one and its area a 'low.' At a variable distance above the earth's surface the crest of the cyclone is struck and carried away forward by the prevailing over-current, which in the tropics is the returning loop of the uplifted trades as they journey west, after that this same loop becoming the antitrade as it takes a brief turn poleward, and finally the prevailing westerlies in the temperate regions.

Now it is well known that the prevailing westerlies, or any other steady winds blowing across a mountain chain, draw up the air on the leeward side of the mountain, condensing its moisture into a constant cloud. There is also a well-known instrument now widely used by surgeons and painters, which consists of a tube opening at right angles to the mouth of another tube which dips into the fluid to be sprayed. By blowing through the first tube a liquid is made to rise up through the second or perpendicular one. In both these instances the horizontal current, by the momentum of its trajectory, has to a greater or less extent removed the pressure of the superincumbent atmosphere and permitted the surrounding pressure to force the air or the liquid upward.

Now in the case of the beheading of our cyclonic mountain, the available energy is the momentum of the horizontal trajectory of the upper prevailing winds. Twenty-seven inches of mercury is probably the extreme of 'low' for any cyclone, and this shading off to zero at the edges, so that an average fall of one inch over the entire area of a cyclone is the highest probably ever attained if, indeed, it goes nearly so high. This prevailing wind is operative at from 2,000 feet to ten or more miles high, while moving at a speed of from, say, 50 to 250 miles an hour. But, whether it embraces the entire operative force or not, this prevailing overcurrent supplies a vast amount of the energy of motion to cyclones and is to that extent a *vera causa*. Again, the translatory energy, as well as the gyratory, may be derived from the same source. While the crest of the cyclonic mountain is being dragged away forward, the body of the cyclone itself is made to lean in the same direction. In this case air, drawn into the cyclone from in front, reaches its body at a given height in less time than a like mass drawn in from the rear, and this still more when the cyclone is in motion. The result altogether will be that the diameter of the base of the cyclone is added to more rapidly in front than in the rear. This of necessity results in a forward movement of the center of gravity; and, since the cyclone is rotating, it must continuously advance in order to make its axis correspond with its center of gravity. Indeed, so much is this the case that the axis of a cyclone is probably curved—advanced at the base and at the top while lagging in the middle.

D. T. Smith.

SPECIAL ARTICLES.

RECENT DISCOVERIES OF QUATERNARY MAMMALS IN SOUTHERN CALIFORNIA.

Several months ago Mr. F. M. Anderson called my attention to a deposit of bones occurring in asphalt beds near Rosemary Station about nine miles west of Los Angeles. In a small collection of specimens kindly presented to me by Mr. Anderson there were represented a number of Quaternary mammalian species which are either new to the fauna of the Californian region or have been very imperfectly known.

Recently Mrs. Ida Hancock, the owner of the property on which the asphalt deposits are located, has very kindly given to the University of California permission to carry on excavation work in these beds, and a considerable collection of valuable material has been obtained.

The beds in which the bones occur extend over many acres. So far as I am aware the bottom has not been reached in excavations carried to the depth of at least fifteen feet in quarrying the asphalt. Bones are scattered

through a large part of the deposit, but are very unevenly distributed. In some localities they are present in large numbers and in fairly defined layers.

The asphalt has in many cases penetrated even the minute pores of the bone, but the original material of the skeleton is practically unchanged.

The remains recognized up to the present time include the following forms: *Elephas, Equus, Bison,* a mylodont, *Smilodon, Canis indianensis* (?), *Canis* (small species), and camel remains. Numerous bird bones and remains of insects are also found.

In a considerable number of cases large parts of skeletons are found together, showing that the carcasses were entombed so quickly that there was not sufficient time for decomposition to permit separation of the parts.

Of the specimens obtained up to the present time an extraordinarily large percentage represent carnivora. The number of carnivores is certainly relatively larger than the usual percentage in a well-balanced fauna, and this abundance must be attributed to peculiar conditions under which the bones accumulated. Undoubtedly most of the remains are those of animals that have been entrapped or mired in the asphalt at times when it formed a deposit around tar springs. The surface of the asphalt is very sticky in some places at the present time, and where cuts are opened in it tar may ooze out. Such pools have probably existed here interruptedly through a long period, and particularly during Quaternary time when the deposit was forming. Carnivores are numerous because they were attracted by birds and mammals caught in the asphalt. Perhaps it is not entirely a coincidence that the carnivore remains are usually associated with those of birds or mammals, which would be their natural prey. The considerable number of young sabre-tooth cats present may indicate that the younger and less experienced individuals were more easily lured into the tar pools.

During the first examination of the beds several small, pebble-like bones were obtained which resembled the dermal ossicles of the ground-sloth, *Grypotherium,* recently described by Dr. A. Smith Woodward[1] from skin fragments obtained in a cave at Last Hope Inlet, Patagonia. The ossicles were in association with remains of a large ground-sloth somewhat similar to *Mylodon* in foot structure. Realizing that the peculiar conditions of accumulation offered an especially favorable opportunity for preservation of the dermal armor of a ground-sloth, during the second study of the deposits an attempt was made to find a specimen in which the armor might be recognized. Several hundred yards from the location of the first specimen, a large scapula resembling that of a mylodont was found partly exposed, with a row of small ossicles immediately over the outer side. The section of the bed containing these bones has recently been worked out, and the row of small bones proves to be the edge of a distinct layer including between 250 and 300 individuals. They mantle over the outer surface of the scapula, being removed from it by about an inch of asphalt.

The layer of bones as we find it has probably been disturbed somewhat and does not occupy its original position exactly, but the fact that it remains as a distinct layer with a tendency toward similar orientation of the individual ossicles indicates that the disturbance has not been great. As the position of the layer in the asphalt was nearly vertical, the presence of the large number of ossicles together may not be attributed to the washing together of scattered elements on the floor of a small basin of deposition.

The ossicles are not closely pressed together and are not superimposed. The individuals range in size from a cross-section of 6.5 x 4.5 mm. to 21 x 16 mm. Excepting a few of the largest ones, which are nearly square, the greater number are rounded and rather irregular in form. The outer side is in some cases more regularly modeled than the inner. The surface of the bones is somewhat roughened or pitted in some instances, but no markings are present which would be considered as definite

[1] A. Smith Woodward with Dr. F. P. Moreno, *Proc. Zool. Soc. Lond.*, 1899, pp. 144–156, pls. 13–15; also A. Smith Woodward, *Proc. Zool. Soc. Lond.*, 1900, pp. 64–79, pls. 5–9.

sculpturing. The microscopic structure has not yet been examined.

In general the form, size and arrangement of the ossicles are much as in the bones in the *Grypotherium* skin from Patagonia. The skin fragment first described by Woodward was thought to represent mainly the region of the neck and shoulder. The Californian specimen mantles over the outer side of the scapula, and is presumably not far removed from its original position with relation to this bone. The generic position of the form represented by this specimen appears as yet somewhat uncertain, but a satisfactory determination of its affinities will probably be possible when the skeletal material available has been finally assembled.

John C. Merriam.

A SUGGESTION FOR INTENSIFYING THE DÖPPLER EFFECT.

It has never been pointed out, I believe, that the relation between the conjugate foci of a concave mirror furnishes, at least in theory, a means of enormously intensifying the Döppler effect. If we have a source of light a little outside the principal focus of a concave mirror we shall have an inverted image formed at a considerable distance; and if the source move toward or from the mirror the image will move in the opposite direction with a much greater speed.

Let f_1 and f_2 be any two conjugate focal distances, and F the principal focal distance; then

$$\frac{I}{f_1}+\frac{I}{f_2}=\frac{I}{F}$$

Differentiate with respect to t;

$$-\frac{I}{f_1^2}\frac{df_1}{dt}-\frac{I}{f_2^2}\frac{df_2}{dt}=0$$

Writing v_1 and v_2 for the speeds of the source and the image, we have

$$\frac{v_1}{v_2}=-\frac{f_1^2}{f_2^2}$$

that is, the speeds are proportional to the squares of the distances from the mirror.

To show the theoretical possibilities of this formula let us suppose a source of light moving with a speed of 10^3 cm. per second at a distance of 10 cm. from the mirror, whose focal length, of course, must be a trifle less than this figure; at what distance must the image be formed in order that its speed shall be 10^{10}, one third of the speed of light?

$$\frac{x^2}{10^2}=\frac{10^{10}}{10^3}$$

$x=316$ meters, nearly, a distance obtainable in the laboratory with a moderate number of reflections.

The chief difficulty to be overcome in any experiment of this nature would be the faintness of the image due to its great size. A continuously moving source of light could be obtained either by a wheel with mirror teeth or with a self-luminous rim.

Paul R. Heyl.

Central High School, Philadelphia.

THE COMPULSORY RETIREMENT OF THE DIRECTOR OF THE BRITISH MUSEUM OF NATURAL HISTORY.[1]

In a letter which we publish to-day Professor Ray Lankester, who is this year president of the British Association, tells the story of the summary termination of his directorship of the Natural History Museum, some imperfect versions of which have obtained currency. The standing committee of the trustees have taken advantage of the civil service rule that the head of a department may call upon any officer in it to retire at the age of sixty, upon such pension as he is entitled to by the general regulations. That rule is not usually acted upon in the absence of some special reason, unless the officer has completed such a term of service as entitles him to the *maximum* pension. Dr. Lankester was appointed at the age of fifty-two, so that when he reaches sixty next May a regulation intended to apply to men who have spent their lives in a government office decrees that his pension shall be £160, which the treasury of its goodness may raise to £300. In any country but this it would be thought grotesque and monstrous that a distinguished man of science asked to serve the state after the age

[1] From the London *Times*.

of fifty, with his abilities fully tested and his scientific reputation fully established, should be treated on the same footing as a clerk who might never have done anything but copy documents and perhaps post a ledger. In this country there used to be a way of mitigating the absurdity of the system. The treasury could in such cases add twenty-one years to the service for pension purposes, thereby enabling a man joining late in life on some special ground to be put in a position not much worse than that of an undistinguished copyist joining early. But in recent years the treasury has curtailed its own powers and can not now add more than seven years. Were another Newton to-day made master of the mint, and were he to be dismissed or to become incapable of performing his duties five years afterwards, he would receive at the most a pension calculated on twelve years' service. That is how this nation enlists knowledge and ability for the carrying on of its affairs. But that is not by any means the worst it can do. A man may serve it like Lord Milner for a long term of years in difficult and arduous positions, but if he is not technically in the civil service he may be dismissed into private life at an age when other remunerative employment is unattainable, without any compensation at all.

No explanation has been vouchsafed to Dr. Lankester for the cavalier treatment he has received. His eminence in his own scientific field is unquestionable, and has been abundantly recognized by those most competent to judge both abroad and at home. Nor is he one of the unpractical students who do not know how to handle business. On the contrary, he has all the qualities required in an efficient administrator. We are thrown back, therefore, upon reasons of a more personal kind. He was appointed by the three principal trustees in whom power of appointment and dismissal is vested by statute. But the appointment was resented by some active members of the standing committee, which has taken the first opportunity to reverse it. It may be presumed that he has not succeeded in conciliating those who were opposed to his appointment, and as he holds his own views rather strongly and is not too patient with what presents itself to him as stupidity, it is even possible that he has not tried very hard to conciliate them. In most situations in life it is necessary to reckon with these personal factors, which indeed may be raised to the dignity of impersonal factors in circumstances where harmonious cooperation among many becomes as important as the most commanding ability in one man. If the difficulty in the present case is of this order, it may now be regarded as insuperable. Dr. Lankester himself would probably recognize that, whatever the causes, his usefulness at the museum and his own comfort in remaining there are alike at an end. But, though this may be a good reason for the severance of his connection with the museum, it is no reason at all for turning him adrift at the age of sixty with a derisory compensation calculated upon rules intended for a totally different purpose. If he does not 'get on' with the other people in the museum probably there are faults on both sides, and too much zeal for science may have been one of his. In any case failure to get on with somebody else is not by a very long way misconduct of the kind that forfeits a position. He gave up a secure position at Oxford to take the directorship, trusting to a general but not well-founded impression that the state may be relied upon to treat its servants with generosity. There are not many things open to a man of sixty; and there are few suitable to the student of biology. The museum may manage its affairs in its own way, but it is a disgrace to the nation to treat a distinguished man of science, entering its service in exceptional circumstances, as if he were an ordinary clerk, merely because an absurd technicality places both in the same category.

SUMMER MEETING AND COLLOQUIUM OF THE AMERICAN MATHEMATICAL SOCIETY.

THE thirteenth summer meeting of the society will be held at Yale University, New Haven, Conn., on Monday and Tuesday, Septemper 3 and 4.

A colloquium will open on Wednesday, Sep-

tember 5, and close on the following Saturday morning. One course of five lectures will be given by Professor E. H. Moore, of the University of Chicago, and two courses of four lectures each by Professor Max Mason, of Yale University, and Professor E. J. Wilczynski, of the University of California. Titles and outlines of the courses are as follows:

On the Theory of Bilinear Functional Operations: Professor E. H. Moore.

In the light of the general theory of distributive functional operations and with emphasis on various analogies between algebraic and transcendental theories, the course is to consider bilinear functional operations, in particular the theory and applications of linear integral equations, as recently developed by Volterra, Fredholm, Hilbert and others. The general point of view with references is to be found in the article on functional operations by Pincherle in the Encyclopedia, II A $_{11}$.

Selected Topics in the Theory of Boundary Value Problems of Differential Equations: Professor Max Mason.

The course will deal with the real solutions of partial and ordinary linear differential equations of the second order. The analytical character of the solutions of partial differential equations of elliptic, parabolic and hyperbolic types will be discussed. Boundary value problems for equations of these types and for ordinary differential equations will be treated, with special reference to the applications of definite and indefinite integral equations and of Green's functions. The relation between boundary value problems and corresponding problems in the calculus of variations will be considered. Special reference will be made to writings of Hilbert, Picard, Hadamard and Bernstein, and to recent Göttingen dissertations. The lectures will not assume a knowledge of the theory of boundary value problems or of calculus of variations.

Projective Differential Geometry: Professor E. J. Wilczynski.

Differential geometry has, heretofore, been almost exclusively treated from the point of view of the group of motions. In the present course, which is confined to plane and space curves, and ruled surfaces, those properties are investigated which depend upon the infinitesimal elements of the configuration considered but which are invariant under all projective transformations. The references will be principally to the work of Halphen and that of the lecturer, which has been collected in a treatise soon to be published by B. G. Teubner under the same title as this course. Some knowledge of the theory of linear differential equations and of the theory of continuous groups will be assumed.

The morning lectures will begin at 10, the afternoon lectures at 2:30. Each lecture will occupy an hour, and consecutive lectures will be separated by an intermission. Two lectures will be given on each morning, Wednesday to Saturday, inclusive, and on each of two afternoons, and one lecture will be given on Wednesday evening at 8. One afternoon will be devoted to an outing. A charge of three dollars will be made to those attending any or all of these lectures.

James Pierpont,
Percy F. Smith,
Heinrich Maschke,
H. S. White,
F. N. Cole,
Committee on Summer Meeting.

SAMUEL LEWIS PENFIELD.

Samuel Lewis Penfield, professor of mineralogy in the Sheffield Scientific School of Yale University, died at South Woodstock, Conn., on August 12, 1906, at the age of fifty years. He has been continuously connected with the Sheffield School since his graduation from that institution in 1877.

Professor Penfield, as a student, made a specialty of analytical chemistry, and developed wonderful ability in that line of work. Soon after graduation he made many difficult analyses of minerals, particularly of phosphates from Branchville. He studied organic chemistry at Strasburg University in 1880–81, but immediately afterwards he became instructor in mineralogy at New Haven, and thenceforward devoted his whole attention to

that branch of science. He returned to Germany in 1884 to study crystallography and related subjects at the University of Heidelberg.

Penfield accomplished a vast amount of scientific work. Being a master of both the chemical and physical sides of mineralogy, he was able to make the most thorough researches, and he described many new minerals and reinvestigated many old ones. His scientific publications appeared chiefly in the *American Journal of Science,* and many of them were brought together in book form in the 'Studies from the Mineralogical and Petrographical Laboratories of the Sheffield Scientific School.' One of his important achievements was his prediction of the possible existence of an unknown mineral of the humite series, which was afterwards found and described by a European mineralogist.

As a teacher, Penfield was eminently successful. He inspired enthusiasm in his coworkers to a remarkable degree, and a number of his former pupils have become prominent in mineralogy. He devised many means for aiding the student and his laboratory became a model for the best methods of instruction; he revised and enlarged the standard work on Determinative Mineralogy of his teacher, predecessor and friend, Professor Brush; he wrote a number of pamphlets for the use of laboratory students, and besides mineralogical publications, he published important papers on analytical chemistry, cartography and crystal-drawing.

Penfield was a member of the National Academy of Sciences, and was foreign member or correspondent of many European Scientific Societies. He received the degree of LL.D. from the University of Wisconsin in 1904.

H. L. W.

SCIENTIFIC NOTES AND NEWS.

THE University of Greifswald, on the occasion of its celebration of its four hundred and fiftieth anniversary, conferred the degree of doctor of laws on Dr. W. W. Keen, professor of surgery in Jefferson Medical College.

DR. JOHN M. CLARKE, state geologist of New York, has been elected corresponding member of the Royal Academy of Sciences of Göttingen.

THE French Academy of Moral and Political Science has elected Lord Reay a foreign associate member in succession to the late M. Olivecrona. Lord Reay has been a corresponding member of the moral science section of the academy since 1902.

DR. STANISLAO CANNIZZARO, professor of chemistry at Rome and senator of Italy, has celebrated his eightieth birthday.

THE second annual course of lectures given by the Harvey Society of New York will be opened on October 20, 1906, by Professor A. E. Wright, of London. Nine other lectures are to be given during the year, the lectures and dates being as follows: November 3, C. A. Herter; November 17, W. T. Porter; December 1, J. G. Adami; December 15, George Huntington; January 12, F. G. Benedict; January 26, E. B. Wilson; February 9, S. J. Meltzer; February 23, W. T. Councilman; March 9, Friedrich Müller. The officers of the society for the coming year are Graham Lusk, president; Simon Flexner, vice-president; F. S. Lee, treasurer; George B. Wallace, secretary, and C. A. Herter, S. J. Meltzer and James Ewing, council.

THE prize of the Heidelberg Jubilee Foundation for the Encouragement of Scientific Research has been awarded to Dr. Friedrich Pockels, professor of theoretical physics, and to Dr. August Klages, professor of chemistry.

THE University of Strasburg has awarded the income of the Engelmann foundation for history or geography to Dr. Kalkoff, professor in the Gymnasium at Breslau.

DR. D. T. MACDOUGAL, of the department of botanical research of the Carnegie Institution of Washington, left New York on August 18 to carry on some observations in the deserts about Tehuacan south of the city of Mexico, in which he will be joined by Dr. J. N. Rose, of the U. S. National Museum. Dr. MacDougal expects to arrive at the Desert Laboratory, Tucson, Arizona, with the experimental

material secured, in the latter part of September.

Mr. M. L. Fuller, in addition to the supervision of the underground water work of the United States Geological Survey in the eastern United States, will spend a portion of the field season in an investigation of the underground waters of the Cincinnati region and adjacent portions of Ohio and Indiana. Associated with him will be Mr. F. G. Clapp and S. R. Capps. The work will include studies of the rock waters and the waters of the drift, and will be both geological and chemical.

Professor H. E. Gregory, of Yale University, will devote a part of the present field season to the completion of an investigation of the underground waters of Connecticut for the United States Geological Survey. The study of the waters of crystalline rocks has already been completed, leaving only the limestones and Triassic rocks to be examined. A large number of analyses will be made of typical waters with a view to determining their suitability for public supplies, for use in steam boilers or in industrial processes.

Mr. Whitman Cross, geologist, of the U. S. Geological Survey, is making areal surveys in the San Juan district, Colorado. He is assisted by Messrs. Albert Johannsen and L. H. Woolsey.

An areal survey of the Riddles quadrangle, Oregon, is being made this summer by Mr. J. S. Diller, geologist of the U. S. Geological Survey, assisted by Messrs. G. F. Kay and James Storrs. Preparation for this season's work was made last year in tracing the definite Jurassic rocks from the southwest into the Riddles quadrangle, where they come closer together and apparently render it possible to determine their relations. This quadrangle affords an opportunity to study the whole series of igneous rocks of the Klamath Mountains, with which the mineral resources are most intimately associated. A general examination of the mines in the quadrangle will be made.

Dr. A. T. Howard, professor of pathology in the Medical School of Western Reserve University, will spend next year abroad engaged in special investigations.

Dr. C. Graebe, professor of chemistry at Geneva, has retired with the title of honorary professor.

A despatch from Christiania, Norway, says that, according to private letters received there from Spitzbergen, Mr. Walter Wellman has abandoned the attempt to reach the North Pole by balloon this year, owing to the lateness of the season.

A National Society for the Preservation of the Public Health will be established at a meeting to be held at the Hudson Theater, New York City, on November 15.

The United States Civil Service Commission announces examinations as follows: On August 29–30, to fill three vacancies in the position of forest assistant in the Philippine Service, at $1,400 per annum, and similar vacancies as they may occur in that service; on September 12, to fill vacancies in the position of miscellaneous computer at the Naval Observatory; on September 12–14, to fill a vacancy in the position of engineer draftsman, at $1,500 to $2,000 per annum, in the Reclamation Service, Geological Survey; on September 12–13, to fill vacancies, as they may occur, in the position of aid in the Coast and Geodetic Survey, at $720 per annum each; on September 19, to fill a vacancy in the position of assistant photographer (male), at $480 per annum, in the Geological Survey, and vacancies, as they may occur, in any branch of the service requiring similar qualifications; on September 19, to fill a vacancy in the position of economic botanist and mycologist in the Bureau of Science at Manila, P. I., at $1,400 per annum, and vacancies, as they may occur, in the Philippine Service requiring similar qualifications; on September 19–20, to fill vacancies in the position of examiner, at $1,800 per annum, and assistant examiner, at salaries ranging from $1,200 to $1,600 per annum, in the Reclamation Service of the Geological Survey, and similar vacancies, as they may occur; on October 1, to fill vacancies in the position of constructing en-

gineer, in the Reclamation Service of the Geological Survey, at $150 to $250 a month. The great majority of these positions are for field service in the western part of the United States and in places remote from cities and ordinary lines of transportation.

LORD KELVIN writes as follows to the London *Times:* "In your yesterday's issue, under heading 'British Association,' I read 'In the Mathematical and Physical Section, a discussion was opened by Professor Soddy on the possible transmutation of the elements. * * * The statement that the production of helium from radium has established the fact of the gradual evolution of one element into others was not seriously questioned.' I wish to remark that an isolated experimental discovery by Sir William Ramsay and Professor Soddy, brilliantly interesting as it is and solidly instructive as it is towards the theory of radium, suggests nothing more towards any modification of the atomic doctrine proposed some 2,500 years ago by Democritus, and universally adopted by chemists and other philosophers in the nineteenth century, than does Ramsay's original discovery of helium as an emanation from the mineral clevite. The obvious conclusion from the two discoveries is that clevite and radium both contain helium. I can not refer, thus publicly, to discussions on radium in the meeting of the British Association which commenced last Wednesday in York without protesting against the hypothesis that the heat of the sun or earth, or other bodies in the universe, is due to radium. I believe it is mainly due to gravitation; and I believe that the experimental results on which the radium hypothesis has been built give no foundation on which it can rest."

AN experimental and teaching station for the study of economic plants and the home production of medicinal and industrial vegetable products was opened last month near Landskrona in Sweden. The establishment, erected by the provisions of Consul Oscar Ekman, of Stockholm, was dedicated to the Swedish nation under the name Esperanza. Consul Ekman, now in his ninety-fourth year and formerly associated with the Carnegie industrial interests, previously donated considerable sums to the universities of Upsala and Göteborg, and has been active for many years also in the promotion of popular enlightenment. In the establishment of the new station he was guided mainly by a desire of resuscitating the home culture of useful plants formerly quite common, as well as by the fact that raw materials of this class are now being imported into Sweden at a great cost. Among the problems first to be considered are the cultivation of mint. The oil of peppermint never was produced on a scale sufficient for the demand, and Sweden's supply thereof is nearly all imported. The home production of chamomilla, a plant formerly cultivated about every country home; the cultivation on a large scale of caraway, pigment plants, textile and fiber herbs is also considered. Two directors have been appointed. The botanical work is in charge of Director Tom von Post, of the Upsala Seed Control Station, who made an investigation, last year, of the principal European centers of peppermint culture. Mr. Hjalmar Lindström, a practical pharmacist of Landskrona, will have charge of the technical and industrial branches of the work.

D. H. Ross, Canadian commercial agent at Melbourne, reports that two Australian inventors have discovered a new process for the continuous treatment of iron ore, and he says that the results they have achieved are so successful that the process is to be exploited throughout the world. It is called the Heskett-Moore process for directly converting iron ore into malleable iron or steel by a continuous system, and it is claimed effects a saving of 25 per cent. in the manufacture. The ore is simply concentrated by ordinary methods, or if it is magnetic it is separated electrically until the pure oxide of iron is obtained. The oxide of iron is passed through a revolving cylinder heated by waste gases from subsequent operations and brought in that cylinder to a dull red heat. It drops from the cylinder to a second similar cylinder, and in the latter it is brought into contact with the deoxidizing gas, which is forced

through and brought into contact with the heated ore. The heated ore is thus converted into a pure iron. Accompanied by and protected by the deoxidizing gas, it is passed into a third chamber or melting hearth, where it falls into a bath of molten iron and is converted directly into steel or balled up as malleable iron. The savings claimed for the process are those of time, labor—the whole process being automatic—fuel and avoidance of flux. The inventors claim that they have discovered a direct method of producing steel from one operation instead of using the blast furnace and converter.

UNIVERSITY AND EDUCATIONAL NEWS.

THE following additions have been made to the faculty of Stanford University, to begin work with the coming academic year:

George Hempl, of the University of Michigan, as senior professor in German.

Allyn Abbott Young, of the University of Wisconsin, as associate professor of economics.

Thorstein Veblen, of the University of Chicago, as associate professor of economics.

William Dinsmore Briggs, of Western Reserve University, as assistant professor of English.

C. A. Huston, of the University of Chicago, as instructor in law.

Payson J. Treat, of Stanford University, instructor in history.

Frank E. Thompson, of the State Normal School of San Diego, instructor in education.

Hubert H. Hall and L. L. Carter, both of Stanford University, instructors in civil engineering.

Lawrence E. Cutter, of Stanford University, instructor in mechanical engineering.

Frederick A. Manchester, of the University of Wisconsin, instructor in English.

Pierre Comert, of the University of Paris, instructor in French.

Homer P. Earle, of Stanford University, instructor in Spanish.

W. O. Mendenhall, of Haverford College, instructor in applied mathematics.

Rennie W. Doane, of Stanford University, instructor in entomology.

William E. Burke and William H. Sloan, both of Stanford University, instructors in chemistry.

Luther Burbank, of Santa-Rosa, lecturer on plant evolution.

Ephraim Douglass Adams has been promoted to a professorship in history and Edward Curtis Franklin to a professorship in organic chemistry; Hans Frederik Blichfeldt to an associate professorship in mathematics; and Charles Henry Huberich to an associate professorship in law. Henry Suzzallo has been promoted to an assistant professorship in education; Anstruther A. Lawson to an assistant professorship in botany; Kenneth Livermore Curtis to an assistant professorship in electrical engineering; Arthur Martin Catheart to an assistant professorship in law; and Henry David Gray to an assistant professorship in English. The work of repairs of earthquake damages at Stanford University has been placed in the hands of a commission of the engineering faculty composed of Professors Charles David Marx, William F. Durand and Charles B. Wing. The repairs have progressed so far that all necessary rooms are ready for the work of the coming academic year, which begins on August 23, 1906.

LEMENUEL W. FAMULENER, B.S. (Michigan, '02), Ph.C. (Michigan, 1900), M.D. (Michigan, '06), has been appointed assistant professor of pathology in Indiana University. Dr. Famulener was for three years Nelson Baker and Co. research fellow in pharmacology under Dr. Cushny at the University of Michigan, and for one year a worker with Dr. Mansen in the Statens Seruminstitut at Copenhagen, Denmark.

DR. BRUCE FINK, of Iowa College, has been appointed professor of botany at Miami University, Oxford, Ohio.

JAMES T. ROOD, Ph.D., has been elected professor of mathematics and physics at Ursinus College, Collegeville, Pa.

MR. DIARMID NOËL PATON, superintendent of the laboratory of the Royal College of Physicians, Edinburgh, has been appointed regius professor of physiology in the University of Glasgow, in place of Professor J. G. M'Kendrick, resigned.

DR. EUGENE ALBRECHT, director of the Senckenbergische Institut at Frankfort, has been called to the chair of pathology at Marburg.

DR. GUSTAV STEINMANN, of Freiburg, has been called to a chair of geology at Halle.